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Zeolitic Imidazolate Framework (ZIF) glasses are a newly emerged family of melt-quenched (MQ) glasses [1-3]. ZIFs are a subset of metal-organic frameworks (MOFs). Very recently, ZIF-62 has been found to be an outstanding glass former [4], which has a chemical formula of $Zn(Im)_{1.75}(bIm)_{0.25}$, where Im and bIm refer to imidazole ($C_3H_3N_2^-$) and benzimidazole ($C_5H_7N_2^-$), respectively. MQ ZIF-62 glass exhibits a number of interesting features such as ultrahigh Passion's ratio and high transparency [3]. However, producing a bulk sample from ZIF-62 is a challenge, mainly because of a limited amount of reactants accessible to an optimum reaction and of high oxidation probability of the sample during heating-quenching protocol. The latter factor leads to degradation of the framework during the melt-quenching process.

In this work, we optimize the production process of ZIF-62 glass to get large-sized bulk samples by adjusting various parameters such as melting temperature, time and gas used in an electric furnace. Samples of around 200 mg were produced, by heating to 460˚C and varying the dwell time. With extension of melting time, an interplay between homogenization of the sample and decomposition caused by remnant oxygen has been observed. Final glass samples were characterized by measuring density and by taking scanning electron microscopy from cross-sections of the sample. Glass transition temperature was determined by performing differential scanning calorimetry and thermogravimetry measurements. Hardness measurements were also conducted in order to initially assess the influence of dwell time at 460˚C on mechanical properties and cracking behavior of bulk ZIF-62 glasses. Finally, we have obtained homogeneous glasses of diameter of about 1 cm. This work provides some information that is useful for upscaling of MOF glass production.

References:

[1] T.D. Bennett, J.C. Tan, Y.Z. Yue, et al., *Nat. Commun.* 6 (2015) 8079.
[2] T.D. Bennett, Y.Z. Yue, P. Li, et al., *J. Am. Chem. Soc.* 138 (2016) 3484.
[3] H.Z. Tao, T.D. Bennett, Y.Z. Yue, *Adv. Mater.* 29 (2017) 1601705.
[4] A. Qiao, T.D. Bennett, H.Z. Tao, et al., *Sci. Adv.,* Vol.3, no. 4 (2018), eaao6827.